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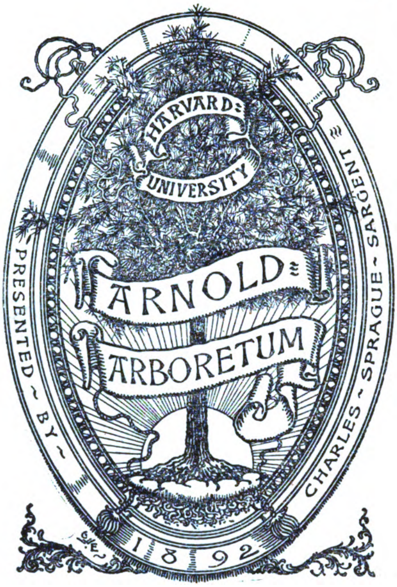


~~DEPOSITED AT THE
HARVARD FOREST
1943~~

RETURNED TO J. P.
MARCH, 1967

THE

FERRUM TIMBER COMPANY

FOR

THE UNITED STATES OF AMERICA,

ORGANIZED FOR THE

PRESERVATION OF TIMBER FROM DECAY

AND FROM THE

RAVAGES OF THE MARINE WORM.

Office of the Company, 229 Broadway, New-York.

New-York:
FRANCIS HART & COMPANY, PRINTERS, 63 CORTLANDT STREET.
1865.

THE

FERRUM TIMBER COMPANY

INCORPORATED JULY 18, 1865.

(ORGANIZED UNDER THE GENERAL LAWS OF THE STATE OF NEW-YORK.)

FOR PRESERVING TIMBER.

CAPITAL STOCK, $2,000,000—20,000 SHARES $100 EACH.

OFFICE OF THE COMPANY, 229 BROADWAY, NEW-YORK.

New-York:
FRANCIS HART & COMPANY, PRINTERS, 63 CORTLANDT STREET.
1865.

[illegible]

OBJECT OF THE COMPANY.

The object of this Company is to introduce a cheap and effective process for preserving timber, both from decay by *rot* when exposed to the action of moisture, air and heat upon land, and from the attacks and ravages of the innumerable *marine worms* that infest the waters along the coast.

Besides protection from decay, this process improves the natural qualities of the timber, by increasing its hardness or density, its flexibility, elasticity and strength; prevents its expansion and contraction, and reduces its combustibility. It also favors the application of various persistent colors to the different varieties of wood.

The apparatus employed in this process was invented some sixteen years ago, in Hungary, by A. Hamar, who has by letters patent from the United States secured the right to its exclusive use here, in impregnating timber with certain substances. This Patent has been assigned to this Company.

In order to realize the great advantages which the method of preserving timber offered by this Company possesses over all others which have heretofore been presented to the public, it may be pertinent to consider the purposes to which timber is applied, and the enormous consumption for some of those purposes,—the importance of durability of timber, its growth and composition, the nature and causes of its decay, the effect of the attacks of worms, the means of preservation to which resort has been heretofore had, and the use which can be made of the softer and more perishable sorts of timber, when preserved and improved by this means.

TIMBER AND ITS USES.

WOOD—the most abundant product of vegetation—is the well-known hard substance which constitutes the principal portion of the roots, trunks and branches of *Trees* and *Shrubs*. Woody plants which do not attain to any considerable height are called SHRUBS, while those which reach a height of thirty feet or more and do not branch near the ground, are known as TREES.

For the purposes of building and repairing Houses, Ships, Docks, Bridges, Railway Tracks, &c., &c., woods of considerable bulk become necessary or desirable, and can be obtained only from trees. It is to such wood taken from the trunks of trees that the name TIMBER applies.

The number of sorts of timber in use in the different countries, for the purposes of construction and the arts, is very great, though but few may be employed, or familiarly known in any particular locality. From Canada to Mexico there are no less than 140 species of trees that grow to the height of thirty feet.

Of the numerous varieties of trees the Oak is the most extensive and interesting genus. About seventy different species of this tree are described by various authors as natives of America.

The numerous species of Oak possess almost every variety of character. They differ greatly in their magnitude, in the texture, strength and durability of their timber, the size, taste and abundance of their fruit, the form, color and odor of their leaves. The timber of one kind is almost as firm and durable as iron, while that of another is so loose and open in its texture as to be classed among the soft woods.

The most important varieties of Oak known in the United States are the *White Oak*, *Iron Oak*, *Mountain Oak*, *Over Cup White Oak*, *Mossy Cup Oak;* *Swamp Chestnut Oak*, *Swamp*

White Oak, *Yellow Oak*, *Red Oak*, *Black Oak*, *Scarlet Oak*, *Pin Oak* and *Live Oak*. To the same order—the Oak Tribe—belong the *Chestnut*, the *Red Beech* and the *White Beech*.

Of nearly, if not quite equal importance to the Oak, is the Pine tribe of trees, The principal of these in the United States are the *White Pine*, *Red Pine*, *Yellow Pine*, *Pitch Pine*, *Hemlock*, *Black Spruce*, *White Spruce*, *Tamarack* and *Balsam Fir*.

Next to the Oak, the Walnuts are the most numerous trees in American forests. The principal of these are the *Black Walnut*, *Hickory* and *Butternut*. Of the Hickory there are four or five varieties in the State of New-York. The Shell-Bark Hickory is the most compact, strong and elastic of any wood growing in the United States. Yet it is chiefly valuable for fuel, and not for timber, on account of its perishable nature.

Belonging to the divers other tribes, the following species may be mentioned as abundant in various parts of the United States. The hard or *Sugar Maple;* the *White* and the *Red Maple;* the *Black*, *Red*, *Yellow* and *Canoe Birch;* the *White*, *Thomas'* and *Red Elm;* *White* and *Black Ash;* *White* and *Red Cedar;* *White* and *Yellow Poplar;* *Tackmahack*, *Sycamore*, *Locust*, *Virginia Poplar*, *Cotton Wood*, *Aspen*, *White Wood* and the *Cucumber Tree*.

The importance of some process by which the duration of the lifetime of timber may be prolonged can hardly be estimated when its present enormous consumption is considered, together with the fact that while the demand is constantly increasing, the supply is very rapidly diminishing.

The once immense White Pine forests of New England, New-York and other States, have almost entirely disappeared, while the Oaks have become so scarce that their timber commands double the price of the Pine.

Besides the vast quantity of Oak and Chestnut employed in ship building, the greatest demand for these particular kinds of timber is, perhaps, for railway sleepers. The price of Oak and Chestnut sleepers has, at least, doubled within the last fifteen years. Pine and most of the other timbers have been found too soft to hold the spikes, and resist the pressure of the iron rails, or they decay too rapidly to be sought after for sleepers, so long as the Oak and Chestnut can be obtained.

RAILWAY SLEEPERS.

In the 26 States between the Mississippi River and the Atlantic Ocean there have been put in operation no less than 30,000 miles of railway tracks, which will require annually for renewals an average of at least 16,000,000 sleepers, equal for durability to Oak and Chestnut in their natural condition. Moreover, in the same States, from two thousand to three thousand miles more of tracks are already in progress, or contemplated to be soon built.

In England the ordinary life-time of railway sleepers is said to be about seven years, but by chemical preparation they are rendered durable from fifteen to twenty-five years. The saving in this way is so great that some mode of preservation is adopted on nearly all foreign railways.

While in the climate of England the Oak of that latitude may endure, in its natural state, for seven years, the experience of this country is that the same sort of timber will not last for sleepers more than about five years. In the Southern States, decay is excessively rapid.

Railway sleepers of an average size contain, in England, 3⅓ cubic feet, or 40 feet B. M. In the United States the average is, probably, 2½ cubic feet, or 30 feet B. M. This will give 40,000,000 cubic feet, or 480 million feet B. M. as the annual supply of Oak and Chestnut sleepers required to maintain the railways already in use east of the Mississippi, and without which, or an equivalent, those roads cannot be kept in running order.

The forests bordering on these roads have already been divested of their most suitable material for this purpose. Future supplies must come from greater distances, year after year, until the demand exceeds the possible supply, or until the cost compels the substitution of cast iron, or the adoption of some mode of preservation of wood, however expensive it may be.

On several of the English Railways, cast iron sleepers have already been adopted at a cost of about $7,000 per mile of single track. On the ordinary railways of England, sleepers prepared to last fifteen years, laid in place, cost nearly $3,000 per mile, which is equal to about $1.30 per sleeper containing 2½ cubic feet.

In the United States, Oak and Chestnut sleepers, re-laid in a ballasted track, cost from 50 cents to $1.00, and on an average not less than 75 cents each; of which 25 cents may be set down as the labor and expense, besides the first cost, or price paid for the sleeper delivered somewhere contiguous to the line of the road.

The price of sleepers has doubled in the last fifteen years, and will undoubtedly again double within the next fifteen or twenty years at farthest. This will be an increase of cost at the rate of five per cent. per annum.

It is believed that Oak and Chestnut sleepers may be preserved for fifteen or twenty years by Hamar's process, at a cost of less than *ten* cents per sleeper, and that, under favorable circumstances, where a considerable quantity of them can be cut from large timber, the cost will not exceed five cents. It is also believed that the common timber of the country, in any district through which a railway is laid, when prepared by the proposed process, will endure longer and cost far less than the best specimens of Oak and Chestnut in their natural condition.

IMPORTANCE OF DURABILITY.

The great economy of durable timber consists in saving the expense of reconstruction. In many cases the labor of replacing costs more than the material itself. Besides, experience teaches that, for every renewal of timber, the cost of the material, if not of the labor, becomes greatly enhanced.

The present cost of Oak and Chestnut sleepers, delivered, being 50 cents, it is assumed that they will cost 62½ cents in five years, and 75 cents in ten years from this time. Let the value of the labor of taking out the old Sleeper and putting in the new one, at any time, be called 25 cents. The cost per annum for fifteen years will then be as follows, assuming a sleeper for every two feet of track :

2,640 Sleepers laid now at 75 cents	$1,980.00
2.640 " " 5 years hence, at 87½ cents	2,310.00
2,640 " " 10 " " at $1.00	2.640.00
Total cost for 15 years	$6,930.00
Cost per mile per annum	462.00

By preparing the first lot of the sleepers so as to last fifteen years, at an additional cost of 10 cents, the cost for 15 years will be only for

2,640 Sleepers laid now at 85 cents	$2,244.00
Cost per mile per annum	149.60
Saving " "	312.40

For the length of tracks on the Erie Railway, this saving would amount to $280,000 per annum, or a dividend of 1⅛ per cent. on the Capital Stock. On all the Railroads in the United States the saving would be about $10,000,000 per annum.

This vast saving may, undoubtedly, be increased by preserving and hardening the Hemlock, Spruce, Cotton Wood and other species of the common timber of the country, some sorts of which are to be found abundant and cheap on most of the railway lines of the United States.

Hamar asserts that not only will his process preserve timber from decay for fifteen to twenty five years, or for an indefinite period, but will increase the strength and hardness of the timber to such a degree as will actually obliterate the difference of durability between the hard and the soft woods. As proof of this he refers to the sleepers of the Austrian and Hungarian railways, of soft wood prepared by his process more than ten years ago, which have answered every requirement and withstood every test as well as Oak or any other kind of hard wood might have done.

For the preservation of wood from rottenness it is first of all necessary to change its component parts by expelling those that are detrimental and substituting preservatives in their stead. Woody fibre itself will resist putrefaction for a considerable length of time, but the *sap* is the substance which sooner or later generates rottenness. Hamar's process first expels the *sap* completely, and next replaces it by the Chemical Compound for preservation.

The expulsion of the sap, and the introduction of the chemicals, is produced by a simple and inexpensive appliance of hydrostatic and atmospheric pressure, which acts almost instantaneously throughout the pores of the whole timber subjected to the process. The chemicals vary according to circumstances and the different kinds of timber to be preserved.

For a more complete understanding of the mode of preparing timber by this and other processes, some knowledge of the composition and manner of growth of wood, becomes important.

GROWTH AND STRUCTURE OF TIMBER.

If the trunk of a tree be cut across, its section will present three principal features, the *bark*, the *wood*, and the *pith*.

The PITH is the soft and spongy substance, or cellular tissue, at the centre of the wood or heart of the tree.

The BARK envelopes the entire wood, and is divided into the *epidermis*, which is a thin skin forming the extreme outside covering: the *cellula* which constitutes the principal thickness of the bark, consisting of an infinite number of tubes or cells, and the *liber* which is the inner and newly formed bark.

The WOOD is the material between the pith and the bark. In new shoots the pith and the bark are in contact without any wood between them, but as the shoot extends, it enlarges by the deposit of a secretion between the bark and the pith. Of this deposit a small part is formed into inner bark, and the other hardens into wood.

At the commencement of the second year's growth, a spontaneous separation of the layer of wood and the innermost layer of the bark, or the *liber*, takes place, and the intervening space becomes occupied by the deposit, as before, of a viscid gelatinous liquid, known as *cambium*. In this liquid are deposited elongated cells or tubes, which form the woody tissue of another layer of wood immediately surrounding the first year's layer. This second year's layer of wood is quite similar to that formed in the first year, to which it is firmly attached. The increase of wood goes on in this manner, circle around circle, each year, so that with young trees, where the line of distinction between the layers is easily perceived, the age of the tree may be estimated by the number of layers. The reason why these yearly increments are defined, is, that the woody tissue formed toward the close of the growing season is denser and more compact than that formed at the commencement.

The tubes which form the woody tissue vary in diameter from $\frac{1}{3000}$ to $\frac{1}{150}$ of an inch. They do not appear to have any communication with each other; no pores are perceptible in their sides. They are very tough and usually cylindrical, but have sometimes a prismatic form. They extend the whole length of the trunk, closely packed together, and serve to convey the sap from the roots upwards to the branches and leaves.

In trees of less than eight or ten years old there is usually no perceptible difference in the density of the several layers of the woody tissue, but after the lapse of ten or twelve years the two or three interior layers become considerably hardened and pass into the state of Timber, properly so called. The interior hardened layers are distinguished as the *heart wood,* and the softer exterior layers as the *ap wood.*

The sides of the tubes of the *sap wood* are very thin, and hardly any solid matter is contained in the interior of these tubes, but merely sap. They are the principal channels by which the sap is conveyed from the roots to the leaves.

The course of the circulation of the sap is this: The crude thin sap from the roots of the tree ascends through the tubes of the previously formed wood to the leaves, where it undergoes condensation and elaboration, and then returns through the vessels of the bark. This returning sap charged with organizing matters in a mucilagenous state, deposits, during a summer, between the bark and the outer layer of wood previously formed, the material which constitutes a year's growth.

As the rings of wood are successively deposited, one each year, directly beneath the bark and around the previously existing wood, the diameter of the tree increases, and the wood toward the heart is compressed by the new growth, as that becomes more solid. Consequently, less sap, from year to year, will flow through the pores of the first formed wood, while the part nearer the bark, being less compressed, and comparatively soft and porous, will take up the greater part of the circulation.

The superior hardness and durability of the heartwood is owing, besides its compression, to the thickening of the sides of the tubes by the deposition of various solid matters; as the debris of disintegrated tubes, and cells, resins, insoluble compounds of tannin with matters derived from the sap, coloring matters &c., which impart peculiar characters to different species of woods. The sap wood has nearly the same appearance in all trees.

The conversion of sap wood into heartwood takes place very rapidly in some trees; as the Oak and Teak; in others, very slowly or not at all, as the Poplar and Willow. After the formation of heartwood is once commenced the number of layers of sap wood usually continues the same at all stages of the growth of the tree, consequently a layer of heartwood is produced annually. This heartwood itself is not of the same density throughout; its interior layers gradually attain a maximum density, which is acquired by other layers in yearly succession. After having remained for some time at the maximum density, the interior layers seem to lose their vitality, becoming lighter in color, softer, weaker and readily altered by the action of decomposing agents.

Although nearly all kinds of wood float on water, yet the weight of pure woody fibre is about one half greater than that of water. The apparent lightness of wood is owing to the presence of a large quantity of air, in the cells or pores of the wood, which is not displaced by water at common atmospheric pressure without a very long digestion.

According to Count Rumford, the specific gravity of the true woody fibre is much the same for all kinds of woods, only varying between 1.53, which is that of Oak and Beech, and 1.46, which is that of Fir and Maple. The mean specific gravity of pure woody fibre may then be taken at 1.5, which is at the rate of 93¾ lbs per cubic foot of perfectly solid wood. The specific gravity of the different kinds of woods, in their ordinary state, must therefore indicate their porosity or the proportion of air within their pores.

The amount of contraction which takes place through desiccation, or drying, is very different in different woods. In some soft woods it amounts to half an inch in a foot. Green wood contains 20 to 50 per cent. by weight of sap; Birch has 30, Oak 35, Beech and Pine 39, Elm 44, and Poplar 50 per cent. From three to six per cent. of dry wood, is solid matter derived from evaporation of the sap, in which it was previously held in solution. The principal part of this is a substance termed *Vegetable Albumen*, which closely resembles animal albumen (white of egg) both in properties and composition. Different woods vary much in the proportion of albumen which they contain. A considerable quantity of *starch* is deposited in the interior vessels of the wood, in the winter season, which is capable of being extracted by mechanical means.

The composition of washed and dried wood from the Oak and Beech, has been found to be: Carbon, 51.45; Oxygen, 42.73; and Hydrogen, 5.82. Total, 100 parts. In which $5.82\ H + 42.73\ O = 48.55$ water.

DECAY OF TIMBER.

Pure woody fibre is composed of carbon united with the elements of water, and undergoes change slowly. The Sap Wood, which abounds with saccharine and fermentable principles, is of a much more perishable nature than the Heart Wood. It is to some condition of the sap the decay of timber must be attributed, and it is now commonly understood to be owing to a vegetable growth which takes place within the pores of the wood, the sap having carried up the minute seeds of the fungus during the growth of the tree.

Decay proceeds with most rapidity in the open air, but the contact of air is not absolutely necessary. In all cases water is essential and is the principal agent. It is the action of moisture and oxygen on the outer surface of the timber and within its pores, upon the substances contained within the sap, which results in a decomposition called putrefaction by chemists, but in common language is known as *Rot.*

Common Rot is occasioned by alternate exposure to the vicissitudes of weather; to moisture and dryness, to heat and cold. Wood exposed to the air turns brown, or of a dark color, and undergoes a slow burning. The change that here occurs is the same as in active combustion, the only difference being that in the first case it takes years to effect its consumption, while in the other it is accomplished in minutes. Under the conditions of air, moisture and heat, this decay is hastened. It ordinarily begins with a sort of fermentation and continues by moist decomposition until the timber looses its structure and woody character, and finally is converted into a mass of *humus.* The common rot may be seen at a point where a beam enters a wall, or on a pile "between wind and water." It commences on the outside of the timber, and gradually works its way inward. As the causes here are extrinsic, a coating of paint, or of tar, will often suffice to protect the wood, for a considerable time, from this manner of decay.

Dry Rot commences within the body of the timber, however well this may be protected by paint or varnish. Without any indication of its existence outside, it goes on converting the fibre of the wood into dry dust, and spreading from the internal parts outward. The causes are inherent in the timber and only require the concurrence of a few conditions to come into action. It has been proposed to designate this malady *Sap rot*, since the elements of it chiefly abound in the outer layers of the wood, and when its direful action has begun it proceeds to the internal as well as the more external layers, until the entire structure becomes involved.

In the living tree dry rot is not readily produced, but a constant tendency to putrefactive fermentation exists which only waits the presence of some acid for its commencement. Decay frequently begins at the heart of a still growing tree.

RAVAGES OF WORMS AND INSECTS.

Besides the decay of its parts, timber is subject to be destroyed by worms and insects. Soft woods of which the juices are of a saccharine nature are more liable to be attacked by them than the harder woods. Against the common worm almost any of the usual preventives of decay may be used with success.

The bottoms of ships, and timber exposed to the action of the sea, are often destroyed by the SHIP WORM, or *Teredo Navalis.* This creature, also variously called the *Pile-Worm,* and *Pipe-Worm,* is at first very small, but soon acquires considerable size, and is sometimes a foot or more long. Its head is provided with a hard calcareous substance, which performs the office of an augur and enables it to penetrate the hardest wood.

These worms attack wood immersed in the sea water, whether ships, piers, or piles, boring in the direction of the grain of the timber. When a piece of wood, constantly under water is occupied by these worms, there is no sign of damage to be seen on the surface, nor are these worms visible till the outer part of the wood be broken or cut away. Wood is eaten by them till it becomes like a honey comb.

In Norfolk harbor these animals make their appearance about the first of July, and during the summer grow from 6 to 12 inches in length and generally to about ⅜ of an inch, at most, in diameter. After the winter has passed away these animals may sometimes be found still alive in many of the cells: but it is not known that the same insect continues its depredations during a second season.

Another *Pile* or timber *Worm* is the *Limnoria Terebrans.* This apparently insignificant animal is from ⅛ to ⅙ of an inch long, oblong linear body and rounded extremities, with two pairs of jaws and a pair of strong mandables, which are the boring organs. It attacks in, countless numbers, the piers of bridges, wooden wharves, piles and all submerged timber in salt water, piercing it in every direction and soon rendering it useless. It has been computed that a stick of timber exposed to these animals, where they are abundant, will lose an inch of its diameter annually. They act chiefly below low water mark. They attack in preference, Pine and other soft woods, although none, except perhaps Live Oak, is exempted from their ravages.

PRESERVATION OF TIMBER.

The utility of timber depends greatly upon its more or less rapidly perishable nature. To preserve it from destruction is of equal importance to first obtaining it, and any process by which the decay of wood can be prevented, is of interest to all who have any regard for science or the arts, and is especially worthy of the attention of those who have large investments in railways and the kindred improvements of the day.

Timber in its natural state, is liable at any time to change its nature and part with its most valuable properties; but the fact was long since established in Europe, that the decay of timber can be greatly retarded, if not wholly prevented. Various methods for arresting decay, and, also, for preventing the ravages of worms, have from time to time been adopted with greater or less degrees of success. The object of most of these have been to counteract, or, more properly speaking, to postpone the operation of those causes of decay, which are inherent in wood and all organized bodies. They effect this, however, in the majority of cases, in a very limited and inadequate degree; for still decay occurs, and succeeds in reducing structures to dust and ashes.

No timber is fit for use in the state in which it is felled. The tissues being then distended with sap, are liable to contractions when the water of the sap evaporates, or, if placed in a confined situation, the humid nitrogenized matter in the sap rapidly decomposes.

The juices of the wood should, as far as possible, be at first expelled. The common process by which this result is secured, is called SEASONING.

The ordinary mode of seasoning timber consists in merely exposing it to a free current of air. If the pieces are thin, twelve months' exposure in a dry situation will complete their desiccation to the extent required, but for thick pieces, several years are necessary.

Seasoning in dry air, though it may cause the destructive juices to be hardened, and thus remain harmless so long as they continue in this condition, is proved to be imperfect when the wood is exposed in a damp situation. The moisture penetrating the pores re-dissolves these juices, and the fungus soon makes its appearance. Wood that has lasted well for 650 years, has, by exposure in an unfavorable situation, been attacked in a few weeks by dry rot.

The seasoning of wood is effected better and more rapidly by previously washing out or diluting the sap, which may be accomplished by exposing the wood for some weeks to running water, or by boiling the wood in water. Steamed timber dries sooner than that which is boiled.

In 1657, more than 200 years ago, Glauber discovered the method of preserving timber by first carbonizing its surface by the action of fire, then coating it with vegetable tar and immersing it in pyroligneous acid.

In 1798, Volmiester discovered a process of washing and immersing timber in a solution of sea salt.

Since the beginning of the present century a great variety of processes have been discovered and patented for the preservation of timber, among which, and nearly in the order of their dates, are the following:

1. Filling the interstices of the wood with dry salt.

2. Repeated immersions in the sea.

3. The wood first boiled in water and then concentrated acids applied.

4. Immersion in chloride of mercury.

5. Repeated immersion in vegetable tar, from which the pyroligneous acid had been extracted.

6. The wood exposed first to the vapor of water alone, and afterwards to the vapor of tar.

7. Repeated coatings of oil tar, previously treated with gaseous chloride.

8. Saturating with a mixture of fish oil, rosin and sulphur, by coating the wood and rubbing.

9. Extraction, by a vacuum, of the air from heated wood, and the application of a mixture of fish oil, rosin and sulphur.

10. Boiling the wood three hours in a mixture of linseed oil, sulphate of iron, verdigris and alum.

11. Applications, alternately, of saline solutions; forming mutual decomposition and leaving in the wood an insoluble combination; as for instance, *first*, a chloride of calcium; *second*, glauber salt, sulphate of iron, arseniate of soda.

12. The wood being perforated at different points, a mixture of salt, powdered charcoal and oil, is introduced and the holes closed.

13. The wood impregnated with oily and rosinous matters or appropriate salts, by pressure in a vertical cylinder, in the natural state, or after being exhausted of the air and the sap. The exhaustion is performed by means of another large cylinder communicating with the first, into which the steam passes, and is condensed by an injection of cold water, which answers the purpose of an air pump.

14. The wood is exposed for a long time to the smoke of green wood, burning slowly.

15. Immersion in a solution of the chloride of mercury (corrosive sublimate). This process, by **Kyan**, was afterwards changed to the pressure process.

16. Coating or immersion in tar and a decoction of tobacco.

17. Coating and repeated rubbing with a solution of rosin in fish oil.

18. Immersion in solution of india rubber in fatty oils.

19. Repeated coatings of a solution of sulphate of iron, or introduction of wood with beds or layers of iron pyrites.

20. Immersion in lime water.

21. Rubbing with a hot solution of rosin in oil of turpentine.

22. Exposing to the action of the vapor of eupion and creosote in a closed and heated vessel.

23. Coating with concentrated sulphuric acid to carbonize surface of the wood.

24. Immersion in oil tar and pyrolignite of iron.

25. Immersion in refuse water of salt works.

26. Immersion in a solution of chloride of mercury, then dried and coated with glue.

27. The wood first dried, then immersed in a solution of sulphur, or acetate of copper.

28. Immersion from one to two hours in a solution of tar, oil of turpentine and common salt, heated from 275° to 300° F. with or without application of pressure or a vacuum.

29. The wood immersed for 30 days in soluble glass and hydrochloric acid, washed dried and rubbed with oil.

30. Alternate immersion in a chloride of tin or copper, and soda or lime water.

31. Immersion from 10 to 20 days in chloride of zinc. This process of *Burnett* he afterwards changed to the pressure process.

32. *Bethell's* process. Extraction of the air and introduction of bituminous liquors by means of powerful pressure.

33. *Boucherie's* process. Solution of pyrolignite of Iron, pyrolignous acid, muriate of lime, sulphates of copper, chloride of mercury, &c., are introduced by the natural absorbing

power of the living tree, or incorporated with the wood immediately after being cut down.

34. The wood first steamed in a cylinder, a solution of alum, or other salt, is then introduced and boiled by steam. The alum fixed in the wood, is then decomposed by a solution of potash.

35. Charring the surface of the wood by immersion in boiling tar, pitch, rosin or tallow.

36. Immersion in the solution of sulphate or muriate of protoxide of manganese, or in the refuse liquors of the chloride works.

37. Immersion in a solution of nitrate of iron, saltpetre, alum, and ferri potassium.

38. Muriate of lime, sulphate of iron, potassium, alum and potash, applied by the pressure process.

39. Immersion in chloride of mercury.

40. Coating or impregnation of India rubber dissolved in carburet of sulphur or eupion.

41. Immersion in a solution of sulphate of iron or copper.

42. The wood first steamed, then impregnated with a solution of sulphate of iron, and lastly with soluble glass (silica in caustic soda).

43. A solution of silica in caustic soda (soluble glass), is introduced by the pressure process, and the wood afterwards placed in dilute acid.

44. Impregnation by a solution of sulphur or muriate of copper, afterwards decomposed by baryta.

45. Extraction of the air by steam and the alternate introduction by pressure, of solutions of metalic sulphurets (lime and baryta), and afterwards of an acid or metalic salt (sulphate of iron &c.,) which can decompose each other, so as to leave in the wood a deposit of sulphur, or insoluble metalic sulphuret.

46. Immersion in a solution of sulphate of copper—one

pound of sulphate to 40 gallons of water, in a strong vat, till the timber is saturated.

47. Immerse the ends of each piece of timber in any of the hydro carbons, as the oil of schist, or any other sufficiently light and votatile. Set the ends on fire and let them burn till the applied hybro carbon be burned out, then immediately dip them into a hot mixture of pitch, tar and shellac.

48. Immerse, for two or three weeks, in a reservoir or pond of lime water.

49. Timber impregnated with a liquid composed of common salt, ley, and spirits of turpentine.

50. Hamar's process of expelling the sap and infusing certain chemicals and other preservatives into the pores of the wood by Hydrostatic pressure.

Of these fifty processes, 32 are by immersion, painting or coating, smoking, or some other external application; 5 are impregnated in some manner not stated; 6 are boiled or steamed, and 7 are saturated after having the air and sap expelled.

Of the seven cases, mentioned as saturated after the expulsion of the sap, five of them are by what is called the pressure process. These are known as *Kyanizing*, *Burnettizing*, *Paynizing*, *Bethell's Process*, &c., the apparatus for which is substantially the same for each, and was patented in England by Mr. John Bethell in 1838.

This apparatus consists of an air tight iron tank, of sufficient strength to withstand an internal pressure of 200 lbs. per sq. inch.

The tank is fitted with an air tight door and with a common steam boiler safety-valve. It is connected by one pipe with an exhausting air pump, and by another pipe with a pressure pump, for forcing the liquid into the pores of the wood. The wood being introduced into the tank, the tank is exhausted of its air, and the timber of its sap. After a short time the liquid is admitted and forced into the exhausted pores of the wood, by the pressure pump. This is a very expensive apparatus, and by no means a portable one.

Of the other two processes which expel the sap, one is that of DR. BOUCHERIE.

A billet of wood placed on its end, covered with an aqueous solution, gradually absorbs a considerable quantity of liquid, merely by the force of capillary attraction, aided by the pressure of the liquid column. The impregnation takes place with extreme slowness. A piece of wood, about thirty-nine inches long and nine inches in diameter, continued to absorb water and increase in weight after having been submerged in water for ten months.

To obtain a more perfect and rapid impregnation of the wood, Dr. Boucherie suggested the application of the aspirative force of the tree, the liquid being applied either to the base of the trunk or larger branches, or to the roots. It is indifferent whether the tree is still standing or recently felled. By this force the liquid is absorbed, in the course of a few days, to a height of 80 or 100 feet, and even penetrates to the leaves.

To impregnate a tree recently felled, the base of its trunk may be placed in a vat containing the solution of the preserving material; or else a bag of leather, or sheet caoutchouc, may be fastened water tight around the base and put in communication, by means of a pipe, with a tank or cistern containing the solution.

A poplar of about 90 feet in height, the base of which was placed, in the month of September, in a vat containing a solution of pyrolignite of iron, absorbed $10\frac{6}{10}$ cubic feet of the solution in six days.

Dr. Boucherie considered it important that the tree should be maintained in a vertical position, and, in order that its great weight might not become inconvenient to sustain, he often found it more advantageous to operate on the tree before it was wholly detached from its roots.

To impregnate a standing tree, two deep notches were made, with a saw on each side of the trunk, into which two narrow wedges were inserted, to support the tree. A bag of tarred leather was then fastened around the trunk, above and below the notches, and placed in communication by a pipe with a cistern containing the preserving solution: or, otherwise, the solution was contained in a basin of well tempered clay, large enough to hold two or three gallons of liquid, made around the base of the trunk.

The best season of the year for impregnating the tree, according to the experience of Dr. Boucherie, is the autumn. The impregnation is more difficult to effect in deciduous trees in spring than in winter or summer; but evergreens may be impregnated, advantageously, in winter.

An objection to the process of impregnating trees by vital absorption, is that it can only be executed in the sap season, which is limited to a few months in the year, and the cutting of the wood at this period is contrary to established practice.

A similar and equally effective method by which trees may be impregnated at all seasons, has since been discovered by Dr. Boucherie. The process consists simply in inverting the newly felled tree, stripped of all superfluous branches, divided into convenient lengths, and squared if necessary, then applying the preserving liquid to the butt end of the tree, now the uppermost.

The liquid is contained either in a bag of impermeable cloth, adapted to the upper extremity, or in a cup hollowed out of the end of the tree. In most cases the liquid quickly penetrates, by the superior extremity, and the sap flows out at the bottom almost immediately. The operation is terminated when the liquid which issues from the bottom of the piece is the same as that introduced at the top.

The only other process which expels the sap, and which remains to be noticed, is Hamer's, which has sometimes been confounded with that of Dr. Boucherie. By this process the tree is first felled, and the branches separated from the trunk. It may be squared or left in its natural form. A cap or bag is then fitted to one end of the timber, so as to be water tight, to receive any dilute solution of little greater density than water. To this cap is connected a pipe, or piece of vulcanized india rubber hose, which communicates with an elevated tank containing a solution of pyrolignite of iron, or other preserving metallic salt. The solution, being admitted to the pipe, will flow into the cap or bag, follow the sap tubes and expel the sap by forcing it through the whole length of the wood and out at the other end of the timber. An elevation of 25 to 30 feet is sufficient for the tank, and a pressure of 10 to 12 lbs. per square inch is found to expel the sap in a very short space of time.

When the timber is not required to be of the whole length of the trunk of the tree, a saw cut may be made, through about nine tenths of its section, and the tree slightly raised, at the place where sawn, so as to partly open the saw cut. A piece of string, or strand of rope, is then placed around and within the open edges, and the stick dropped to its original position, by which the sawn edges are tightly packed, so that nothing liquid, applied under ordinary pressure to the inside, will work through the joint. A hole is bored obliquely into the saw cut, a wooden nozzle driven in, and this is attached to a flexible tube in connection with the reservoir containing the solution. Sleepers 8 feet long may be fully impregnated in one hour.

Troughs may be placed under the ends of the timber, to catch the waste solution, these troughs leading to a reservoir, from whence the contents may be pumped up to the discharging cistern.

ADVANTAGES OF HAMAR'S PROCESS.

By this process no expensive stationary vats or tanks, either of timber or of iron, are required. A full set of apparatus need not cost more than one hundred to two hundred dollars, and can be transported from place to place on a one horse cart, or even on the back of a mule. With the necessary labor for handling and preparing the timber, as much can be accomplished with one set of this apparatus, as can be done in the same time by one of the expensive machines employed in the pressure process of Bethell, Kyan, Burnett, Payne &c. The cost of the apparatus does not preclude the idea of multiplying its number, and of erecting one at any desirable point. It is designed to be carried to the timber, and not the timber to the apparatus. Besides the chemicals particularly intended to be used, any other known antiseptics may be applied, as well, or better, by means of this apparatus as by any other.

The pressure process, more familiarly known as *Burnettizing* &c., is perhaps the more rapid, cheap and in many respects the best of all the processes heretofore practiced in the United States. But the apparatus costs about $10.000, consisting of an iron cylinder 60 to 70 feet long and 6 feet in diameter, together with a steam engine and boiler of some 25 horse power, large tanks for the solution, pumps, railway tracks, trucks for timber &c. &c.; consequently, it is scarcely more portable than a machine shop, and the timber must be brought to it, however great the distance.

For some purposes, in certain localities, this necessity for bringing the timber to the machine, has not been attended with so much inconvenience and extra expense, as to amount to an insuperable obstacle in the way of using this apparatus for preserving timber; but for other purposes, such as for curing piles, railway sleepers, &c., &c., the cost of transportation *to* and *from* has so far counterbalanced anticipated good results, that very little timber, for these purposes, has been subjected to this process.

The Burnetizing Machine on the Erie Railway, has been almost exclusively employed in preparing bridge timber, car timber, &c. But few sleepers on that road have been Burnetized; partly for the reason above suggested, but principally on account of the machine being fully employed otherwise.

The Erie Railway sleepers are 9 feet long, 6 inches thick, and will average 9 inches wide; being mostly flattened on two sides from the round timber. Consequently, each one will occupy 3⅜ cubic feet of space in the cylinder, which at most will accommodate 1,000 cubic feet. This will give 300 sleepers as a full charge for the cylinder. The number of sleepers per mile on that road is about 3,000, or 10 cylinder charges. 250 sleepers, however, make about the usual charge, which is at the rate of 12 charges per mile. Seldom, or never, is more than one charge put through in one day, but by constant use of the machine, day and night, it would be possible to prepare 11 charges between Monday morning and Saturday night, or one mile per week.

THE FERRUM TIMBER COMPANY are the sole proprietors of *Hamar's* process: the exclusive right to use which in the United States, has been secured by letters patent issued by the patent office of the United States, July 4, 1865.

This process includes not only the method of hardening the timber, but the solution or chemicals used for the purpose. Both the art of the application, and the science of the preservation, are combined. Above all other processes, it is believed this one has superior advantages. It is simple and economical. It can be every where applied. It has endured the test of experiment and time in Hungary and elsewhere in Europe. It is commended both by scientific and practical men, acquainted with the nature and uses of timber.

The Company have already received various applications for rights to use the process, chiefly from gentlemen concerned in railroads. It is believed that all the railroad companies in the United States will soon see and desire to share the advantages of this process for preserving their sleepers and bridges.

The process is of vast utility wherever timber is used. Telegraph poles,—railroad sleepers,—bridge timber,—ship timber, dock timber—may be rendered doubly valuable and durable by this preserving and strengthening process.

The Company will grant rights to corporations for their own use, or sell rights for any state or district within the United States.

Applications to be addressed to

JAMES BIGLER,
55 Liberty Street, New-York.

Or, E. L. FANCHER,
229 Broadway, New-York.

APPENDIX.

CHEMICAL ELEMENTS AND COMPOUNDS.

The following Table embraces the principal substances which have been mentioned, as having been employed for the preservntion of Timber, or which enter into the composition of those substances. Also their symbols, and equivalents of weight in the Hydrogen Scale :

Substances.	Symbols.	Equivalents.
Oxygen	O	8.
Hydrogen............	H	1.
Water..................	HO	$1 + 8 =$ 9.
Carbon	C	6.
Carbonic Acid.........	CO_2	$6 + 8 + 8 =$ 22.
Carbonate of Baryta...	$B_a O, CO_2$	$76.7 + 2 \times 8 =$ 92.7
Carbonate of Lime....	$C_a O, CO_2$	$28.5 + 2 \times 8 =$ 44.5
Carbonate of Potash...	KO, CO_2	$47.3 + 2 \times 8 =$ 63.3
Carbonate of Soda	$N_a O, CO_2$	$31.3 + 2 \times 8 =$ 47.3
Sulphur	S	16.1
Sulphuric Acid........	SO_3	$16.1 + 3 \times 8 =$ 40.1
Sulphate of Baryta....	$B_a O, SO_3$	$76.7 + 3 \times 8 =$ 100.7
Sulphate of Copper....	$C_u O, SO_3$	$39.7 + 3 \times 8 =$ 63.7
Sulphate of Iron	$F_e O, SO_3$	$35.2 + 3 \times 8 =$ 59.2
Sulphate of Lime.....	$C_a O, SO_3$	$28.5 + 3 \times 8 =$ 52.5
Sulphate of Magnesia .	$M_g O, SO_3$	$20.7 + 3 \times 8 =$ 44.7
Sulphate of Soda.....	$N\ O, SO_3$	$31.3 + 3 \times 8 =$ 55.3
Sulphate of Zinc	$Z_n O, SO_3$	$40.3 + 3 \times 8 =$ 64.3
Chlorine..............	Cl	35.5
Chloric Acid..........	ClO_5	$35.5 + 8 \times 5 =$ 75.5
Chloride of Mercury..	$H_g Cl$	$100 + 35.5 =$ 135.5
Chloride of Sodium...	$N\ Cl$	$23.3 + 35.5 =$ 58.8
Chloride of Zinc.....	$Z\ Cl$	$32.3 + 35.5 =$ 67.8
Nitrogen	N	14.
Nitric Acid	NO_5	$14 + 5 \times 8 =$ 54.
Nitrate of Copper.....	$C_u O, NO_5$	$39.7 + 54 =$ 93.7
Nitrate of Potash.....	KO, NO_5	$47.3 + 54 =$ 101.3
Acetic Acid (dry).....	$C_4H_3O_3$	$4 \times 6 + 3 + 3 \times 8 =$ 51.
Acetate of Copper.....	$C_u O, C_4H_3O_3$	$39.7 + 51 =$ 90.7
Acetate of Iron (Pyrolignite)	$F_e O, C_4H_3O_3$	$35.2 + 51 =$ 86.2
Acetate of Lead......	$PlO, C_4H_3O_3$	$111.7 + 51 =$ 162.7
Pyroligneous Acid....	$C_4H_4O_4$	$4 \times 6 + 4 + 4 \times 8 =$ 60.
Arsenic Acid..........	A_3, O_5	$75.3 + 5 \times 8 =$ 115.3
Oxide of Copper......	$C_u O$	$31.7 + 8 =$ 39.7
Peroxide of Tin......	$S_u O_2$	$58.9 + 2 \times 8 =$ 74.9
Naptha (coal tar)......	$C_{14}H_{13}$	$14 \times 6 + 13 =$ 97.
Eupion...............	C_5H_6	$5 \times 6 + 6 =$ 36.
Creosote..............	$C_{28}H_{16}O_4$	$6 \times 28 + 16 + 4 \times 8 =$ 216.

HARDENING TIMBER.

The increase which wood experiences in density, by being impregnated with foreign substances, is shown by the specific gravity of different specimens of Beech, cut from a tree of 56 years growth, and each specimen treated differently.

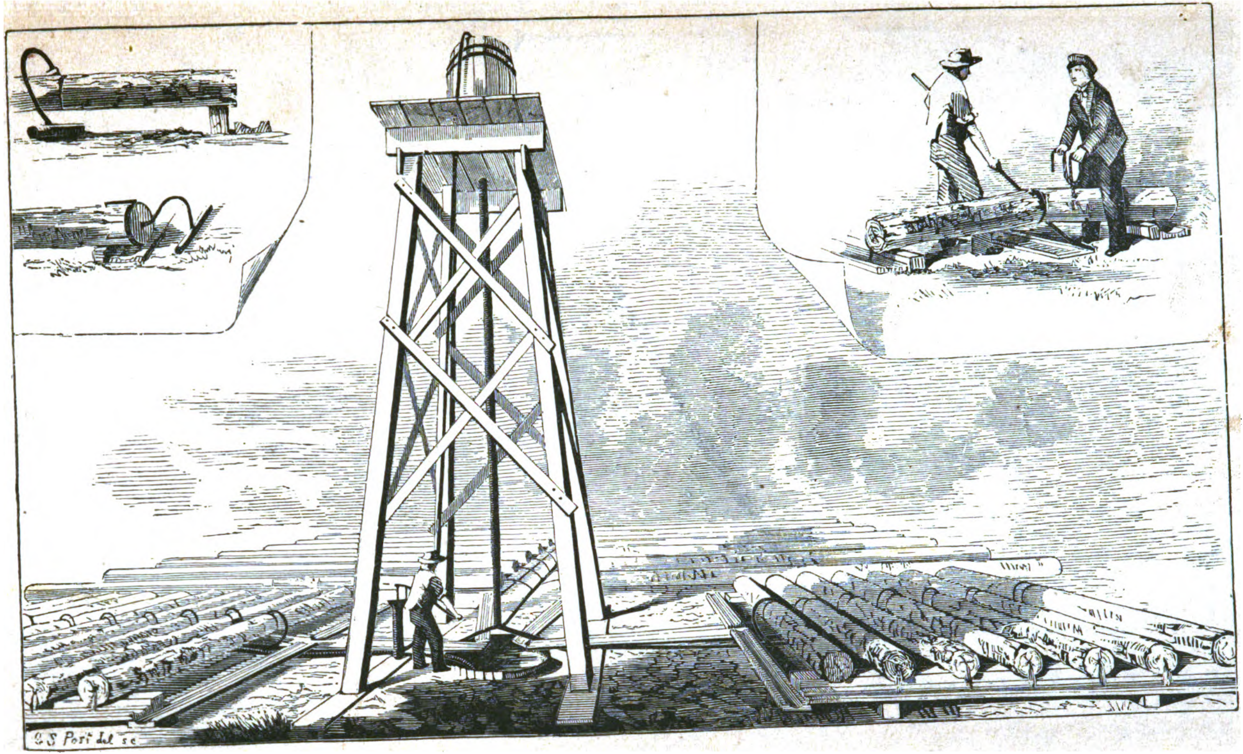
Cut 2 years, and perfectly dried over a stove	.681
Cut 5 years, soaked in water 2 years, dried in air 3 years	.763
Impregnated with Nitrate of Soda, 1 lb. per gall	.809
Impregnated with Sulphate of Iron, ½ lb. per gall	.832
Timber in natural state (green)	.840
Impregnated with Corosive Sublimate, ⅛ lb. per gall	.844
Impregnated with Pyrolignite of Iron	.859
Impregnated with Sulphate of Copper, 1 lb. per gall	.866
Impregnated with Prussiate of Potash, ½ lb. per gall	.876
Impregnated with Chloride of Sodium, 1 lb. per gall	.888
Impregnated with Acetate of Copper, ¼ lb. and Vinegar 1 pint per gall	.937

Experiments on other timber were attended with similar results. Larch was increased from .488, in its green state, to .608 by Pyrolignite of Iron.

RELATIVE HARDNESS OF WOODS.

The Specific Gravity of the principal varieties of Wood used as fuel in the United States, is given in a memoir read before the American Philosophical Society of Philadelphia, April 7, 1826. The specimens, in their natural state, were uniformly prepared by Mr. Bull, and perfectly dried in an oven.

	Common Name of Wood.	Specific Grav.	Weight per Cubic Foot.			
1	Shell-Bark Hickory	1.000	62	pounds	8	ounces.
2	Pig-Nut Hickory	.949	59	"	5	"
3	Wild Service	.887	55	"	7	"
4	Chestnut White Oak	.885	55	"	5	"
5	White Oak	.855	53	"	7	"
6	Red Heart Hickory	.829	51	"	13	"
7	Dog Wood	.815	50	"	15	"
8	Witch-Hazel	.785	49	"	00	"
9	Shell-Bark White Oak	.775	48	"	7	"
10	White Ash	.772	48	"	4	"
11	Swamp Whortleberry	.752	47	"	00	"
12	Barren Schrub Oak	.747	46	"	11	"
13	Pin Oak	.747	46	"	11	"
14	Schrub Black Oak	.728	45	"	8	"
15	Red Oak	.728	45	"	8	"
16	White Beech	.724	45	"	4	"
17	American Hornbeam	.720	45	"	0	"
18	Persimmon	.711	44	"	7	"
19	Sour Gum	.703	43	"	15	"
20	Black Birch	.697	43	"	9	"
21	Apple Tree	.697	43	"	9	"
22	Banen Oak	.694	43	"	6	"
23	Black Walnut	.681	42	"	9	"
24	Rock Chestnut Oak	.678	42	"	6	"
25	Mountain Laurel	.663	41	"	7	"
26	Yellow Oak	.653	40	"	13	"
27	Hard Maple	.644	40	"	4	"
28	Sweet Gum	.634	39	"	10	"
29	Sassafras	.618	38	"	10	"
30	Large Magnolia	.605	37	"	13	"
31	American Holly	.602	37	"	10	"
32	Soft Maple	.597	37	"	5	"
33	White Elm	.580	36	"	4	"
34	Butternut	.567	35	"	7	"
35	Red Cedar	.565	35	"	5	"
36	Yellow Poplar	.563	35	"	3	"
37	Yellow Pine	.551	34	"	7	"
38	Spanish Oak	.548	34	"	4	"
39	Sycamore	.535	33	"	7	"
40	White Birch	.530	33	"	2	"
41	American Chestnut	.522	32	"	10	"
42	Jersey Pine	.478	29	"	14	"
43	Pitch Pine	.426	26	"	10	"
44	White Pine	.418	26	"	2	"
45	Lombardy Poplar	.397	24	"	13	"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